



Original communication

“Bowel wall hemorrhage”: A characteristic sign in hanging death



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ABSTRACT

Bowel wall hemorrhage is recently suggested as a characteristic sign of death by hanging. This prospective cross-sectional study was carried out to determine the frequency of bowel wall hemorrhage in autopsies performed on corpses identified as death-by-hanging in Tehran's autopsy hall. All hanging cases from June 2011 to end of June 2012 were included in this study. Demographic data were collected, physical examination was completed and postmortem changes were recorded in all cases. Autopsies were performed focused to identify bowel wall hemorrhage. Severe putrefied corpses, cases with the history and signs of abdominal trauma, history of coagulopathies and chronic intestinal diseases were excluded from this study.

The frequency and standard deviation were calculated. T-test and Chi-square test were used to analyze the data. 138 hanging cases were studied. Bowel wall hemorrhage was confirmed by microscopic examination in 16 cases (11.6%). The mean age was 35.31 ± 11.41 years. The mean of height, weight and BMI were 173.25 ± 6.06 cm, 71.56 ± 7.76 kg, and 28.80 ± 2.01 kg/m² respectively. Hanging was complete in 9 cases (56.2%).

Our findings show that after exclusion of other conditions leading to intra-abdominal congestion, presence of bowel wall hemorrhage, especially in the small bowel, can be an important sign for death by hanging together with other previously described signs.

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1. Background

Although death by hanging is commonly considered as suicide, it is important to distinguish cases that were hanged after death. Multiple factors facilitate this distinction including evidence collected from the scene, presence of defensive wounds and identification of characteristic hanging signs.¹

A number of nonspecific findings are described including injury of the laryngeal framework and hyoid bone, ligature mark, sign of congestion in the head and neck, histomorphology of lung tissue, indirect lesions such as strain-induced bleeding in the sternocleidomastoid (SCM), and Simon's hemorrhage,^{1,2} hyperemia above and around the ligature mark, positive phosphatide sample,³ pulmonary dystelectasis, pulmonary microempolism syndrome⁴ and sign of aspiration.^{3,5} Some of these reactions are nonspecific and may occur after death.⁶

In 1993, Maxeiner published the first report of bowel hemorrhage after death by strangulation or throttling⁷ but he attributed these findings to mechanical trauma because his study involved homicide samples. Schulz et al., in 2011 described bowel wall hemorrhage as a sign of hanging in 12.1% of their study samples.¹ De la Grandmaison et al. have evaluated rectal wall hemorrhage in hanging cases.⁸ If one rules out other causes of intestinal wall hemorrhage such as coagulopathies, mesenteric infarction, mechanical trauma and artifacts due to putrefaction and hypothermia which are measurable,⁹ presence of bowel wall hemorrhage could be considered as a characteristic sign of hanging.

We carried out this study to determine the frequency of bowel wall hemorrhage in hanged corpses referred to Tehran's autopsy hall from June 2011 to the end of June 2012.

2. Material and methods

In our prospective cross-sectional study, we included all corpses identified as “death-by-hanging” which were referred to Tehran's autopsy hall between June 2011 to the end of June 2012.

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External examination data including head and neck congestion and postmortem changes were recorded. Autopsy was performed in the next step. In our focused autopsy, we recorded presence of subcutaneous and inter muscular neck hemorrhage, injury of hyoid bone and thyroid cartilage, aspiration sign, Simon's hemorrhage and bowel wall hemorrhage.

Other collected data included demographic characteristics, time between death and autopsy, type of hanging and duration of suspension. Corpse with a positive history or sign of abdominal trauma, coagulopathy, intestinal diseases and advanced putrefaction were excluded from this study. Microscopic examination of intestinal specimens was completed by an expert forensic medicine pathologist who was blinded to the causes of death.

Death was suicidal in all cases. Samples were divided and analyzed into two groups based on presence of bowel wall hemorrhage. This study was approved by the ethical committee of Tehran University of Medical Sciences and Department of Forensic Medicine. Written consent was obtained from the family members of the deceased. Data were analyzed by SPSS software. Frequency and standard deviation were calculated. *T*-test and Chi-square test were used for data analysis.

3. Results

We examined 138 hanging corpses. 118 cases (85.5%) were male and 20 (14.5%) were female (male to female ratio was 5.9 to 1). The mean age was 35.5 ± 14.09 years (range: 13–86 years). The mean of height, weight and BMI were 173.25 ± 6.06 cm (range: 155–185 cm), 71.56 ± 7.76 kg (range: 45–140 kg), and 28.80 ± 2.01 kg/m² (range: 14.09–35.5 kg/m²) respectively. Duration between death and autopsy in 107 cases (77.5%) was 12–24 h.

Type of hanging was complete in 61 cases (44.2%) and incomplete in 77 cases (55.8%). The duration of suspension was not determined in 17 cases but in the remaining 121 cases, the mean suspension time was 2.80 ± 5.88 h (range: 0.25–48 h). Primary sign of putrefaction was seen in only 12 cases (8.69%). 27 cases (19.6%) had gross bowel wall hemorrhage distributed as 11 cases (42.3%) in duodenum, 8 cases (30.8%) in jejunum, 1 case (3.7%) in ascending colon, 3 cases (11.1%) in transvers colon, 3 cases both in duodenum and jejunum (11.5%) and one case (3.8%) in duodenum and transvers colon.

Bowel wall hemorrhage was confirmed by microscopic examination in 16 cases (11.6%). Microscopically confirmed cases were distributed as 6 cases (37.5%) in duodenum, 4 cases (25.0%) in jejunum, 1 case (6.25%) in ascending colon, 3 cases (18.75%) in transvers colon, 1 case both in duodenum and jejunum (6.25%) and 1 case (6.25%) in duodenum and transvers colon (Figs. 1–4 show macroscopic and microscopic finding in two cases).

In 11 cases without microscopic confirmation of hemorrhage, sub-mucosal congestion in jejunum was seen in 3 cases and sub-



Fig. 1. Macroscopic findings: multiple small/large patchy, sharply delimited wall hemorrhage in the jejunum.

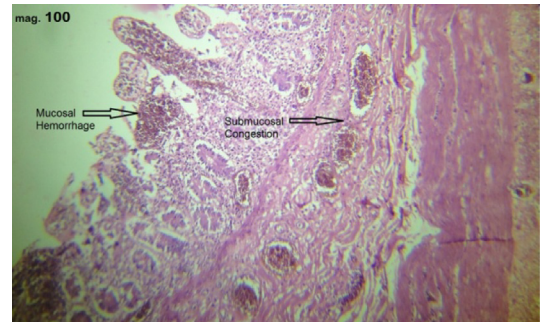


Fig. 2. Histological findings: jejunum-fresh mucosal hemorrhage in tip of intestinal villus and sub mucosal congestion. Hematoxylin–eosin staining.



Fig. 3. Macroscopic findings: large patchy, sharply delimited wall hemorrhage in the transvers colon.

serosal congestion was seen in duodenum in 2 cases. Hemorrhage was observed in pancreas in three cases which were confirmed by microscopic examination.

In autopsies with bowel wall hemorrhage, 14 cases (87.5%) were male (male to female ratio was 7 to 1). The mean age of samples was 35.31 ± 11.41 years (range: 24–61 years). The mean of height, weight and BMI were 173.25 ± 6.06 cm (range: 160–180 cm), 71.56 ± 7.76 kg (range: 50–80 kg) and 23.80 ± 2.01 kg/m² (range: 18.37–27.34 kg/m²) respectively. Duration between death and autopsy in 10 cases (62.5%) was 12–24 h.

Type of hanging was complete in 9 cases (56.2%) and incomplete in 7 cases (43.8%). The duration of suspension was not determined in 4 cases but in the remaining 12 cases, the mean of suspension time was 4.5 ± 8.08 h (range: 1.0–30 h). Sign of putrefaction was seen in only 2 cases (12.5%). Death was suicidal in all cases. Samples were divided and compared based on the presence of bowel wall hemorrhage. Comparison of the characteristics of the two groups and presence of the characteristic sign of hanging are presented in



Fig. 4. Histological findings: transvers colon- fresh mucosal and serosal hemorrhage. Hematoxylineosin staining.

Tables 1 and 2. Besides bowel wall hemorrhage, bleeding in the omentum was observed in 6 cases (37.5%) and bleeding in the stomach was found in three cases (18.8%).

A significant relationship was found between bowel wall hemorrhage, and, subcutaneous and muscular neck hemorrhage ($p = 0.05$) (44.3% in cases without bowel wall hemorrhage vs 18.8% in cases with bowel wall hemorrhage). Also, there was a significant relationship between omental hemorrhage and bowel wall hemorrhage (37.5% in cases with bowel wall hemorrhage vs 4.9% in cases without bowel wall hemorrhage) ($p = 0.000$). Concurrent presence of stomach hemorrhage was seen in 18.8% of corpses with bowel wall hemorrhage versus 5.7% of corpses without bowel wall hemorrhage ($p = 0.059$).

4. Discussion

The frequency of bowel wall hemorrhage in our study was 11.6%. It is similar to the findings of Shulz et al.,¹ which is the only recently published study reporting bowel wall hemorrhage in 12.1% of their samples. Our findings are closely coordinated with the study of Schulz et al. (Table 3) though our sample size is larger (138 cases vs 74 cases). We evaluated bowel wall hemorrhage in a prospective approach whereas previous studies^{1,8} are retrospective.

Diagnosis of bowel wall hemorrhage in autopsy has several differential diagnoses. Except autolysis and its related artifacts, bowel wall hemorrhage can be due to mechanical trauma,¹⁰ diapedetic hemorrhage in congenital or acquired coagulopathies (such as DIC or sepsis)^{9,11} and patchy hemorrhage in hypothermia.¹² Exclusion of putrefied corpses, corpses with history and sign of abdominal trauma, history of coagulopathies and history of chronic intestinal diseases further strengthens our study. We observed the sign of beginning of putrefaction in only 2 cases (12.5%), which is much lower than the study of Shulz et al.¹ None of our cases had any suggestive sign of hypothermia.

Table 1
Comparison of the characteristics of group with bowel wall Hemorrhage with the showing non-bowel wall hemorrhage.

	With bowel wall hemorrhage (n = 16)	Without bowel wall hemorrhage (n = 122)	P
Body characteristics			
Gender			
Male	14 (87.5%)	104 (85.2%)	0.81
Female	2 (12.5%)	18 (14.8%)	
Age (y)	35.31 ± 11.41	35.52 ± 14.45	0.95
Height (cm)	173.25 ± 6.06	173.16 ± 5.82	0.95
Weight (kg)	71.56 ± 7.76	71.66 ± 10.70	0.97
Body mass index (kg/m ²)	23.80 ± 2.01	23.80 ± 2.67	0.99
Autopsy characteristics			
Postmortem interval (h)			
6–12	1 (6.2%)	10 (8.2%)	0.10
12–24	10 (62.5%)	97 (79.5%)	
24–36	3 (18.8%)	5 (4.1%)	
>36	2 (12.5%)	10 (8.2%)	
Putrefaction			
No	14 (87.5%)	112 (91.8%)	0.67
Yes	2 (12.5%)	10 (8.2%)	
Manner of hanging			
Complete	9 (56.2%)	52 (42.6%)	0.30
Incomplete	7 (43.8%)	70 (57.4%)	
Time of suspension (h)	4.5 ± 8.1	2.6 ± 0.53	0.29
Ligature mark			
Complete	3 (18.8%)	18 (14.8%)	0.67
Incomplete	13 (81.2%)	104 (85.2%)	
Toxicology			
Positive	4 (25.0%)	14 (11.5%)	0.29
Negative	12 (75.0%)	108 (88.5%)	

Table 2
Comparison of other vital sign of hanging in group showing bowel wall Hemorrhage with the showing non-bowel wall hemorrhage.

	With bowel wall hemorrhage (n = 16)	Without bowel wall hemorrhage (n = 122)	P
Neck muscle hemorrhage			
Yes	3 (18.8%)	54 (44.3%)	0.05
No	13 (81.2%)	68 (55.7%)	
Hyoid or thyroid hematoma			
Yes	8 (50%)	65 (53.3%)	0.80
No	8 (50%)	57 (46.7%)	
Hyoid fracture			
Yes	2 (12.5%)	26 (21.3%)	0.41
No	14 (87.5%)	96 (78.7%)	
Thyroid cartilage fracture			
Yes	3 (18.8%)	10 (8.2%)	0.17
No	13 (81.2%)	112 (91.8%)	
Simon's hemorrhage			
Yes	5 (31.2%)	25 (20.5%)	0.32
No	11 (68.8%)	97 (79.5%)	
Aspiration sign			
Yes	0 (0%)	1 (0.8%)	0.71
No	16 (100.0%)	121 (99.2%)	
Petechia in conj.			
Yes	2 (12.5%)	41 (33.6%)	0.08
No	14 (87.5%)	81 (66.4%)	
Epicardial Petechia			
Yes	1 (6.2%)	27 (22.1%)	0.13
No	15 (93.8%)	95 (77.9%)	
Lung Petechia			
Yes	5 (31.2%)	60 (49.2%)	0.17
No	11 (68.8%)	62 (50.8%)	

Shulz et al. had explained several hypotheses for bowel wall hemorrhage in hanging.¹ One hypothesis is abdominal congestion with acute dysregulation of circulation that can lead to hemorrhagic infarction of bowel wall layers without hemorrhage into the mucosa.^{1,13} Another hypothesis is prolongation of agonal phases in hanging which can lead to congestion of splanchnic area by acute hypoxemic and vegetative circulatory dysregulation with fluctuations of blood pressure and heart rate during the long agonal phases.¹ According to their hypothesis, systemic hypertension through increased catecholamine secretion in hanging with concomitant anoxic decoupling of the right and left heart in the course of acute circulatory dysregulation could explain bowel wall hemorrhage.¹

In our study, there was no significant relationship between age and bowel wall hemorrhage, yet, the mean age of the group with bowel wall hemorrhage in Schulz et al. study is higher than the group without bowel wall hemorrhage (50 ± 16.6 vs. 35 ± 10.4),¹ therefore, their theory on possible effect of underlying cardiovascular disorder in older people on prolongation of agonal phases and bowel wall hemorrhage is not applicable to our study.

Higher frequency of subcutaneous and inter muscular cervical hemorrhage in cases with no bowel wall hemorrhage in our study (44.3% vs 18.8%) can bring forward the possibility of shortening agonal phase due to increased tension in hanging process, which should be evaluated in future studies. Suspension period was higher in the group with bowel wall hemorrhage (4.5 vs. 2.6 h). Although it is not significant, prolonged suspension period could be a reason for longer agonal phases in this group. Also, prolonged suspension may facilitate hemorrhage by intensifying the effects of gravity.

Based on our results and the study of Schulz et al.,¹ small bowel is much more susceptible to intra mural hemorrhage with bowel congestion than the large intestine. Longer size, motility and circulation of the small bowel may contribute, which should be addressed in future studies.

Table 3

Comparison of major findings in bowel wall hemorrhage group in present study and previous study.

	Age	Height	Weight	BMI	M/F ratio	Type of hanging	Time between death and autopsy	Bowel wall hemorrhage
Present study	35.31 ± 11.41	173.25 ± 6.06	71.56 ± 7.76	23.80 ± 2.01	7/1	Complete 9 cases (56.2%)	62.5% between 12 and 24 h	16 cases (11.6%)
Shulz et al. study ¹	35.0 ± 10.4	175.0 ± 7.30	68.0 ± 15.4	22.7 ± 4.3	2/1	Complete 3 cases (33.3%)	60.0 ± 27.9 h	9 cases (12.1%)

We observed concurrent omental hemorrhage in 37.5% of cases with bowel wall hemorrhage versus 4.9% in the other group ($p = 0.000$). This could be explained by the proposed mechanisms for intestinal hemorrhage. Concurrent stomach hemorrhage was seen in 18.8% of cases with bowel wall hemorrhage versus 5.7% in the control group. Although this difference was not significant, evaluation of hemorrhage in other abdominal organs should be considered in future studies.

In our study, there was no hemorrhage in rectal wall. In 2012, De la Grandmaison et al. evaluated rectal wall hemorrhage in 102 cases of death by hanging and reported 4 cases (3.92%) with rectal wall hemorrhage and two cases (50%) with concurrent bowel wall hemorrhage.⁸ In addition to the theory of abdominal congestion during agonal phases, they attributed this hemorrhage to post-mortem hypostatic hemorrhage (similar to what is seen in neck region).

One limitation of our study was inability to perform autopsies in judicial hanging due to ethical and legal restrains. Autopsy of such cases in controlled and similar situations provides comprehensive data in this field and enables us to test theories of bowel wall hemorrhage. Future and possibly multicenter studies with higher sample sizes should be considered for confirmation of proposed pathophysiological theories.¹

5. Conclusion

Our results show that after exclusion of other causes, bowel wall hemorrhage, especially in the small intestine, can be considered a characteristic sign for hanging in conjunction with other previously known signs.

Conflict of interest

The authors declared no potential conflict of interest with respect to the authorship and/or publication of this article.

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Ethical approval

None.

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